LOS ALAMOS PRIMER

Challenges Facing Stockpile Stewardship in the Second Nuclear Age

CHARLES McMILLAN
Laboratory Director

WELCOME to this issue of National Security Science.

This issue is in celebration of the first Los Alamos Primer lectures, which took place 71 years ago in the spring of 1943. These lectures were held in conjunction with the start-up of "Project Y," which was part of the Manhattan Project. Project Y would eventually become Los Alamos National Laboratory.

The U.S. entry into the Atomic Age had been slow and cautious. But when the United States entered World War II and faced the carnage of the war, fighting and genocide had already claimed millions of lives. Obtaining the bomb before Nazi Germany or Imperial Japan was imperative.

The brightest students (their average age was 24) were recruited from the nation's best colleges and universities. They were joined by other recruits: some of the world's preeminent scientists—for example, Enrico Fermi, Hans Bethe, Edward Teller, and Stanislaw Ulam—many of them refugees from Nazi Germany. The recruits were told very little other than that their work might bring an end to the war. They were given one-way train tickets to the tiny town of Lamy, New Mexico, just south of Santa Fe. There they were met by government agents and spirited away to an undisclosed location in the mountains northwest of Santa Fe.

The youthful recruits, soon to become the world's first nuclear weapons scientists and engineers, knew little about nuclear energy and nothing at all about making an atomic bomb. J. Robert Oppenheimer tasked his Berkeley protégé, Robert Serber, with immediately laying the necessary intellectual groundwork for the arriving scientists.

Serber put the nature of their vital mission bluntly. "The object of the project," he explained to the first several dozen nervous new arrivals, "is to produce a practical military weapon in the form of a bomb in which the energy is released by a fast neutron chain reaction in one or more of the materials known to show nuclear fission."

Using just a blackboard and some brief notes, Serber provided a series of five lectures. He had developed the notes at Berkeley the previous summer while leading a series of secret seminars (which included Oppenheimer, Bethe, and Teller) that explored the potential for building a nuclear weapon. He began the Los Alamos lectures by presenting an essential introductory overview of the relevant nuclear physics. Next, he unveiled the most promising approaches, developed from the secret Berkeley seminars, for building the world's first nuclear bomb.

Following each day's lecture, Serber's original notes were expanded and annotated, based on the questions and discussions traded between audience participants. Formulas, graphs, and simple drawings from the blackboard *were added. The resulting 24-page document was mimeographed and handed out to every newly arriving Project Y scientist.*

The document, titled the Los Alamos Primer, was a slim and parsimonious but powerful map. Although it presented a definitive starting point and destination, and contained several clear landmarks in between, the exact route to building a nuclear weapon was still unclear.

Nevertheless, Project Y's scientists toiled with diligence and determination and managed, by August 1945, to produce two completely different types of practical atomic weapons: Little Boy (a uranium gun-type device) and Fat Man (a plutonium implosion device).

Although the world today is very different from that of 1945, there is still a need to deal with the world's dangers. The United States and its allies remain threatened by traditional nuclear-armed adversaries and new nuclear powers, as well as by states of concern and terrorist organizations seeking nuclear weapons. In this environment, the Laboratory's mission—to do the world-class science needed to meet challenges in national security—has not changed. To succeed, the Laboratory's scientists must above all be free to think critically and examine all possibilities.

As Oppenheimer put it, "There must be no barriers to freedom of inquiry. There is no place for dogma in science. The scientist is free, and must be free to ask any question, to doubt any assertion, to seek for any evidence, to correct any errors. . . .We know that the only way to avoid error is to detect it and that the only way to detect it is to be free to inquire."

As the Soviet Union collapsed, raising concerns about the security of nuclear weapons and materials in the Soviet Weapon Complex, underground testing ended in 1992. This essential tool of U.S. weapons efforts was replaced in 1994 by the Stockpile Stewardship Program. Los Alamos went from designing, engineering, and testing nuclear weapons to stewarding the Laboratory-designed weapons that are aging in the nuclear stockpile, and doing this without full-scale testing. The assessments are reported annually to the president.

The new challenges that stewardship presented the Laboratory were, and still are, daunting. Assessing the health of the stockpile—then, now, and into the future—without additional full-scale testing required building new, revolutionary experimental facilities and investing in new supercomputing, engineering, and manufacturing capabilities. It took less than two-and-a-half years to build the first atomic bombs, but it has taken 20 years of the nation's best scientific efforts to get the Stockpile Stewardship Program as far as it has come today.

How far are we? This new challenge, like the one that began in 1943, is one with a clear objective: a safe, secure, and reliable stockpile. We have made significant strides in stewardship at Los Alamos. Our supercomputers are some of the fastest on the planet. Our Dual-Axis Radiographic Hydrodynamic Test facility is producing world-class radiographs. We have built plutonium pits to support the U.S. Navy, and we are extending the service life of Navy and Air Force weapons.

However significant our successes to date, great scientific challenges remain for stockpile stewardship—assuring that the deterrent remains safe, secure, and reliable without testing requires this capability for the long term.

Because these weapons depend on an in-depth understanding of extremely complicated physics and because the warhead components continue to age, the stockpile continues to present new problems. Although pit aging has begun to be studied, important work remains to be done. As national and international political and economic landscapes shift and as our science and technology improve, there is no foreseeable end in sight to the challenges of stockpile stewardship—nor to the ways of meeting them.

Yet today's austere budget climate threatens our ability to recruit and retain the next generation of scientists and engineers, to optimally use the existing tools of stockpile stewardship; to complete life-extension programs (LEPs) with modern materials and manufacturing that fully meet U.S. military requirements while improving safety and security; and to build the downsized, modernized infrastructure without which we will be unable to carry out our national security mission. In this difficult situation, the path ahead is unclear. But failure is not an option.

The 2nd Los Alamos Primer lectures and discussions, held in July 2013 in honor of the Laboratory's 70th anniversary, explored the changing stewardship landscape, sought new ways to meet its challenges, celebrated our successes, and inspired our current and next generation of scientists. This issue offers our readers an overview of some of those lectures and the challenges we face in stockpile stewardship during the Second Nuclear Age.